REMARKS/ARGUMENTS:

Claims 6, 11, and 20 are amended. Claims 1-21 are pending in the application. Reexamination and reconsideration of the application, as amended, are respectfully requested.

The present invention relates to photoelectric conversion devices used for solar power generation and the like, and in particular, to a photoelectric conversion device using crystalline semiconductor particles and a method of manufacturing the device. (Applicant's specification, at p. 1, lines 9-13).

INTERVIEW SUMMARY:

On March 19, 2008, Patent Agent Barry Shuman conducted a telephone interview with Examiner Asha Hall and the Examiner's Supervisor Alexa Neckel. During the interview the parties discussed the Final Office Action dated January 25, 2008. Specifically, the rejections of claim 1-3 over Bartlett were discussed. The Examiner appeared to agree with the Patent Agent that the Office's interpretation of claims 1-3 was incorrect.

Applicant would like to thank Examiner Asha Hall and the Examiner's Supervisor Alexa Neckel for the courtesy of granting a telephone interview with Patent Agent Barry Shuman.

CLAIM REJECTIONS UNDER 35 U.S.C. § 102:

Claims 1-3 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Bartlett (U.S. Patent No. 4,514,580). Applicant respectfully traverses the rejection. Claim 1 is as follows:

> A photoelectric conversion device comprising:
>
> a substrate serving as a lower electrode;

first conductivity-type crystalline semiconductor particles deposited on the substrate;

second conductivity-type semiconductor layers formed on the crystalline semiconductor particles;

an insulator layer formed among the crystalline semiconductor particles; and

an upper electrode layer formed on the second conductivity-type semiconductor layers,

wherein the second conductivity-type semiconductor layers each have a smaller thickness at or below an equator of each of the crystalline semiconductor particles than at a zenith thereof.

Applicant respectfully submits that Bartlett cannot anticipate or render claim 1 obvious, because Bartlett fails to teach or suggest "the second conductivity-type semiconductor layers each have a smaller thickness at or below an equator of each of the crystalline semiconductor particles than at a zenith thereof."

It is an aspect of the present invention that "an indentation S be provided toward the interior of the particle on a surface below the equator of the crystalline semiconductor particle 3. Providing the indentation S toward the interior of the particle on a surface lower than the equator of the crystalline semiconductor particle 3 can prevent the semiconductor layer 4 from being formed in regions lower than the indentation S. That is, the semiconductor layer 4 formed on the surface of the crystalline semiconductor particle 3 has the largest thickness at the zenith, and gradually becomes thinner as it extends downward from the zenith until the thickness is almost zero at a position below the indentation S. Providing the indentation S allows the semiconductor layer 4 to disappear at an intermediate point between the zenith of the semiconductor particle 3 and the substrate 1. Accordingly, electrical separation between the upper electrode layer 5 and the

substrate 1 can be reliably accomplished. This is favorable because owing to the electrical separation, leak current flowing through the second conductivity-type semiconductor layer 4 to the lower electrode can be reduced." (Applicant's specification, at p. 12, lines 4-25).

The Office at p. 28, 2nd paragraph of the Office Action states,

> "The insulator layer 12 of Bartlett acts as a barrier for the lower half of the first semiconductor type particle 10 creating a gradient region of the exterior of the first type semiconductor particle 10 such that the second semiconductor layer 14 has a thickness less below half of the particle than that of the top of the first semiconductor particle."

Applicant respectfully disagrees. Applicant fails to find where, in the Figures or Specification of Bartlett, the above information is taught or suggested. Perhaps, the Office is considering the thickness of Bartlett's semiconductor particle 10 to be equivalent to the thickness of the second conductivity-type semiconductor layers. In any event, it is Applicant's position that Figure 2 of Bartlett teaches that the thickness of the second conductivity-type semiconductor layer 14 above the equator is the same as the thickness of the semiconductor layer 14 below the equator. (Bartlett, Figure 2).

In light of the foregoing, Applicant respectfully submits that Bartlett cannot anticipate or render claim 1 obvious, because Bartlett fails to teach or suggest each and every claim limitation. Claims 2 and 3 depend from claim 1 and therefore, cannot be anticipated or rendered obvious for at least the same reasons as claim 1. Withdrawal of this rejection is thus respectfully requested.

In addition, with respect to claims 2 and 3, Bartlett fails to teach or suggest the thickness of each of the second conductivity-type semiconductor layers on the crystalline semiconductor particles at or below the equator is 70% (claim 2)/40% (claim 3) or less of that at the zenith thereof.

The Office at p. 3, first full paragraph of the Office Action states,

> "In regard to claims 2 and 3, Bartlett discloses the photoelectric conversion device (Figure 2) as applied to claim 1 above, and further discloses that the first conductivity-type crystalline semiconductor (10) as a particle size of ~300 μm and the thickness of the n-type/second conductivity–type semiconductor (14) layers on the crystalline semiconductor particles at the equator/outline is 0.2 μm of that at the zenith/top portion (col. 3, lines: 50-51 & col. 4; lines 1-3). The n-type/second conductivity-type semiconductor layer (14) is less than 70 and 40% of the zenith/top portion of the semiconductor particle (10)."

Applicant respectfully disagrees. It is the thickness of the semiconductor layer (14) above and below the equator that should be compared. The thickness of the semiconductor particle (10) is not a limitation that needs to be considered in claims 2 and 3.

CLAIM REJECTIONS UNDER 35 U.S.C. § 103:

Claim 4 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett in view of Stanbery (U.S. Patent No. 4,322,571). Applicant respectfully traverses the rejection.

Claim 4 depends from claim 1 and as such includes all the limitations of claim 1, and therefore, cannot be rendered obvious over Bartlett for the same reasons discussed above. Stanbery cannot remedy the defect of Bartlett and is not relied upon by the Office for such. Instead, the Office cites Stanbery for teaching a photoelectric conversion device and a textured surface/indentations/V-shaped ridges so as to optimize the light collection and current generation efficiencies.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claim 4 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claim 5 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett in view of Nakata (WO99/10935). The Applicant respectfully traverses the rejection.

Claim 5 depends from claim 1 and as such includes all the limitations of claim 1, and therefore, cannot be rendered obvious over Bartlett for the same reasons discussed above. Nakata (WO99/10935) cannot remedy the defect of Bartlett and is not relied upon by the Office for such. Instead, the Office cites Nakata (WO99/10935) for teaching a photoelectric spherical semiconductor device and irregularities/rough edges of the core substrate with an elevation difference of 1 micrometer similar to the situation with spherical solar cell that has been sandblasted and a large proportion of the sphere surface is a p-n junction that generates a photovoltage, wherein a large portion of the light reaches the sphere surface, wherein the light is scattered, absorbed, and converted to electricity.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claim 5 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claims 4 and 5 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett in view of Sugawara et al. (U.S. Patent Publication No. 2002/0162585). The Applicant respectfully traverses the rejection.

Claims 4 and 5 depend from claim 1 and as such include all the limitations of claim 1, and therefore, cannot be rendered obvious over Bartlett for the same reasons discussed above. Sugawara (U.S. Patent Publication No. 2002/0162585) cannot remedy the defect of Bartlett and is not relied upon by the Office for such. Instead, the Office cites Sugawara (U.S. Patent Publication No. 2002/0162585) for teaching a photoelectric conversion device with semiconductor spherical particles and pyramidal projections as having an indentation toward the interior thereof at a

surface below the equator/outline and when the pyramidal projection is formed by light that has entered the projection is refracted and direction to the crystalline semiconductor particles so as to contribute to power generation.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claims 4 and 5 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claims 6-8, 10, and 11 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett in view of Stanbery and Arthur et al. (U.S. Patent No. 4,322,571). Applicant respectfully traverses the rejection. Claim 6, as amended, is as follows:

> A photoelectric conversion device comprising:
>
> a substrate serving as a lower electrode;
>
> first conductivity-type crystalline semiconductor particles formed on the substrate;
>
> second conductivity-type semiconductor layers formed on the crystalline semiconductor particles;
>
> an insulator layer formed among the crystalline semiconductor particles; and
>
> an upper electrode layer formed on the second conductivity-type semiconductor layers,
>
> wherein the second conductivity-type semiconductor layers include an impurity element with a concentration decreasing with proximity to the crystalline semiconductor particles, wherein the impurity element comprises one element selected from the group consisting of nitrogen, carbon, and hydrogen.

Applicant respectfully submits that the cited references cannot render claim 6 obvious, because the cited references fail to teach or suggest that "the second conductivity-type semiconductor layers include an impurity element with a concentration decreasing with proximity to the crystalline semiconductor particles, wherein the impurity element comprises one element selected from the group consisting of nitrogen, carbon, and hydrogen."

It is an aspect of the present invention that "when a concentration gradient of oxygen, nitrogen, carbon or hydrogen is provided, significant effects are obtained in terms of improvement of adhesion to the insulator layer 2 and improvement of adhesion to the upper electrode layer 5." (Applicant's specification, at p. 20, lines 18-22).

Bartlett fails to disclose wherein the second conductivity-type semiconductor layers include any type of impurity element with a concentration decreasing with proximity to the crystalline semiconductor particles, much less that the impurity element comprises one element selected from the group consisting of nitrogen, carbon, and hydrogen; and Bartlett is not relied upon by the Office for such. The Office similarly, notes that Bartlett in view of Stanbery fails to disclose wherein the impurity element comprises of one element selected from the group consisting of oxygen, nitrogen, carbon, and hydrogen.

Instead, the Office cites Arthur for teaching a solar cell comprising semiconductor particle and that the particles can be made from high resistivity semiconductor silicon that is undoped or doped with p–type electron acceptor impurities by electrically activating dissolved oxygen in the silicon to change the silicon to n-type. However, Arthur fails to teach or suggest that the impurity comprises one element selected from the group consisting of nitrogen, carbon, and hydrogen.

In light of the foregoing, Applicant respectfully submits that the cited references cannot render claim 6 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Claims 7, 8, and 10 depend from claim 6 and therefore, cannot be rendered obvious over the cited references for at least the same reasons discussed above. Claim 11 requires the similar limitation that at least one element selected from the group consisting of nitrogen, carbon and hydrogen is included in the semiconductor layers. Withdrawal of this rejection is thus respectfully requested.

Claims 12 and 13 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett and Stanbery as applied to claim 11 above, and in further view of Nakata (U.S. Patent No. 6,294,822). The Applicant respectfully traverses the rejection.

Claims 12 and 13 depend from claim 11 and as such include all the limitations of claim 11, and therefore, cannot be rendered obvious over Bartlett and Stanberry for the same reasons discussed above. Nakata (U.S. Patent No. 6,294,822) cannot remedy the defect of Bartlett and Stanbery and is not relied upon by the Office for such. Instead, the Office cites Nakata (U.S. Patent No. 6,294,822) for teaching a photoelectric spherical semiconductor device and electrodes which contact aluminum layer and the n-type/second conductive semiconductive layer with circular openings which reach the surface of the aluminum layer such that the n-type/second conductive layer are formed at two positions which are symmetric with respect to the center of the core to have the electrodes contact the aluminum layer.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claims 12 and 13 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claims 9 and 14-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett and Stanbery as applied to claim 6 above, and in further view of Nakata (U.S. Patent No. 6,294,822). Applicant respectfully traverses the rejection.

Claims 9 and 14-18 depend from claim 6 and as such include all the limitations of claim 6, and therefore, cannot be rendered obvious over Bartlett and Stanbery for the same reasons discussed above. Nakata (U.S. Patent No. 6,294,822) cannot remedy the defect of Bartlett and Stanbery and is not relied upon by the Office for such. Instead, the Office cites Nakata (U.S. Patent No. 6,294,822) for teaching a photoelectric spherical semiconductor device and an oxide layer such as silicon dioxide, passivation film formed over the entire surface of the spherical body and the passivation film reduces the recombination velocity of a minority of carriers and the proportion of photo-generated carriers, which contribute to the photoelectric conversion is increased.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claims 9 and 14-18 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claims 6-16, 20, 21 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett in view of Sugawara et al. (U.S. Patent Publication No. 2002/0023674) and Arthur. Applicant respectfully traverses the rejection.

Applicant respectfully submits that the cited references cannot render claims 6-16, 20, and 21 obvious, because the cited references fail to teach or suggest that the second conductivity-type semiconductor layers include at least "one element selected from the group consisting of nitrogen, carbon, and hydrogen."

As discussed above, Bartlett fails to teach or suggest one element selected from the group consisting of nitrogen, carbon, and hydrogen. Sugawara (U.S.

Patent Publication No. 2002/0023674) similarly, fails to teach or suggest one element selected from the group consisting of nitrogen, carbon, and hydrogen and is not relied upon by the Office for such. Instead, the Office cites Sugawara (U.S. Patent Publication No. 2002/0023674) for teaching among other things a photoelectric conversion device with semiconductor spherical particles (3) as shown in Figure 1, and the n-type/second conductivity type semiconductor layer (4) that has two layers each of which has an impurity addition concentration that differs from the other such that the impurity addition concentration in the lower layer of the second conductivity type semiconductor layer (4) is lower (decreasing) than that in the upper layer of the second conductivity type semiconductor layer. The Office cites Arthur for teaching a solar cell comprising semiconductor particle and that the particles can be made from high resistivity semiconductor silicon that is undoped or doped with p–type electron acceptor impurities by electrically activating dissolved oxygen in the silicon to change the silicon to n-type. However, as discussed above, Arthur fails to teach or suggest that the impurity comprises one element selected from the group consisting of nitrogen, carbon, and hydrogen.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claims 6-16, 20, and 21 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claims 17 and 18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett and Sugawara (U.S. Patent Publication No. 2002/0023674) and Arthur as applied to claim 14 above, and in further view of Sugawara et al. (U.S. Patent Publication No. 2002/0162585). The Applicant respectfully traverses the rejection.

Claims 17 and 18 depend from claim 14 and as such include all the limitations of claim 14, and therefore, cannot be rendered obvious over Bartlett and

Sugawara (U.S. Patent Publication No. 2002/0023674) and Arthur for the same reasons discussed above. Sugawara (U.S. Patent Publication No. 2002/0162585) cannot remedy the defect of Bartlett and Sugawara (U.S. Patent Publication No. 2002/0023674) and Arthur and is not relied upon by the Office for such. Instead, the Office cites Sugawara (U.S. Patent Publication No. 2002/0162585) for teaching a photoelectric conversion device with semiconductor spherical particles and pyramidal projections as having an indentation toward the interior thereof at a surface below the equator/outline and when the pyramidal projection is formed the light that has entered the projection is refracted and direction to the crystalline semiconductor particles so as to contribute to power generation.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claims 17 and 18 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Claim 19 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Bartlett and Sugawara (U.S. Patent Publication No. 2002/0023674) and Arthur as applied to claim 6 above, and in further view of Stanbery. Applicant respectfully traverses the rejection.

Claim 19 depends from claim 6 and as such include all the limitations of claim 6, and therefore, cannot be rendered obvious over Bartlett and Sugawara (U.S. Patent Publication No.2002/0023674) and Arthur for the same reasons discussed above. Stanbery cannot remedy the defect of Bartlett, Sugawara (U.S. Patent Publication No. 2002/0023674) and Arthur is not relied upon by the Office for such. Instead, the Office cites Stanbery for teaching p-type or n-type impurity has high impurity addition concentration at the surface region which provides the cells with a low resistance and excellent ohmic contact properties immediately adjacent to the electrodes.

In light of the foregoing, Applicant respectfully submits that the cited references either alone or in combination cannot render claim 19 obvious, because the combination of references fails to teach or suggest each and every claim limitation. Withdrawal of this rejection is thus respectfully requested.

Applicant believes the foregoing amendments comply with requirements of form and thus may be admitted under 37 C.F.R. § 1.116(b). Alternatively, if these amendments are deemed to touch the merits, admission is requested under 37 C.F.R. § 1.116(c). In this connection, these amendments were not earlier presented because they are in response to the matters pointed out for the first time in the Final Office Action.

Lastly, admission is requested under 37 C.F.R. § 1.116(b) as presenting rejected claims in better form for consideration on appeal.

In view of the foregoing, it is respectfully submitted that the application is in condition for allowance. Reexamination and reconsideration of the application, as amended, are requested.

If for any reason the Examiner finds the application other than in condition for allowance, the Examiner is requested to call the undersigned attorney at the Los Angeles, California telephone number (310) 785-4600 to discuss the steps necessary for placing the application in condition for allowance.

If there are any fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-1314.

Respectfully submitted,
HOGAN & HARTSON L.L.P.

Date: March 25, 2008

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